

411103 085376



NBS SPECIAL PUBLICATION

260-57

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Standard Reference Materials:
**GUIDE TO UNITED STATES
REFERENCE MATERIALS**

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards¹ was established by an act of Congress March 3, 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the Nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau consists of the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Institute for Computer Sciences and Technology, the Office for Information Programs, and the Office of Experimental Technology Incentives Program.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of the Office of Measurement Services, and the following center and divisions:

Applied Mathematics — Electricity — Mechanics — Heat — Optical Physics — Center for Radiation Research — Laboratory Astrophysics² — Cryogenics² — Electromagnetics² — Time and Frequency².

THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to improved methods of measurement, standards, and data on the properties of well-characterized materials needed by industry, commerce, educational institutions, and Government; provides advisory and research services to other Government agencies; and develops, produces, and distributes standard reference materials. The Institute consists of the Office of Standard Reference Materials, the Office of Air and Water Measurement, and the following divisions:

Analytical Chemistry — Polymers — Metallurgy — Inorganic Materials — Reactor Radiation — Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides technical services developing and promoting the use of available technology; cooperates with public and private organizations in developing technological standards, codes, and test methods; and provides technical advice services, and information to Government agencies and the public. The Institute consists of the following divisions and centers:

Standards Application and Analysis — Electronic Technology — Center for Consumer Product Technology: Product Systems Analysis; Product Engineering — Center for Building Technology: Structures, Materials, and Safety; Building Environment; Technical Evaluation and Application — Center for Fire Research: Fire Science; Fire Safety Engineering.

THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides technical services designed to aid Government agencies in improving cost effectiveness in the conduct of their programs through the selection, acquisition, and effective utilization of automatic data processing equipment; and serves as the principal focus within the executive branch for the development of Federal standards for automatic data processing equipment, techniques, and computer languages. The Institute consist of the following divisions:

Computer Services — Systems and Software — Computer Systems Engineering — Information Technology.

THE OFFICE OF EXPERIMENTAL TECHNOLOGY INCENTIVES PROGRAM seeks to affect public policy and process to facilitate technological change in the private sector by examining and experimenting with Government policies and practices in order to identify and remove Government-related barriers and to correct inherent market imperfections that impede the innovation process.

THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System; provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

Office of Standard Reference Data — Office of Information Activities — Office of Technical Publications — Library — Office of International Standards — Office of International Relations.

¹ Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.

² Located at Boulder, Colorado 80302.

FEB 22 1978

Not acc

QC

100

457

NO 260-57

1978

C.2

Standard Reference Materials: GUIDE TO UNITED STATES REFERENCE MATERIALS

* Special Publication

J. Paul Cali

Office of Standard Reference Materials
Institute for Materials Research
National Bureau of Standards
Washington, D.C. 20234

and

Tomasz Plebanski

Polish Committee of Standardization
and Measures
Warsaw, Poland



U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, Secretary

Dr. Sidney Harman, Under Secretary

Jordan J. Baruch, Assistant Secretary for Science and Technology

U.S. NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Acting Director

Issued February 1978

Library of Congress Cataloging in Publication Data

Cali, J. Paul.

Guide to United States reference materials.

(Standard reference materials) (National Bureau of Standards special publication ; 260-57)

Supt. of docs. no.: C13.10:260-57.

1. Materials—Standards—United States. 2. Physical measurements. 3. Chemical tests and reagents—Specifications—United States. Plebanski, Tomasz, joint author. I. Title. II. Series: United States. National Bureau of Standards. Standard reference materials. III. Series: United States. National Bureau of Standards. Special publication ; 260-57.

QC100.U57 no. 260-57 [TA404.5] 602'.1s [602'.1] 77-28819

~

National Bureau of Standards Special Publication 260-57

Nat. Bur. Stand. (U.S.), Spec. Publ. 260-57, 55 pages (Feb. 1978)

CODEN: XNBSAV

**U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1978**

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
(Order by SD Catalog No. C13.10:260-57). Stock No. 003-003-01883-0 Price \$2.20
(Add 25 percent additional for other than U.S. mailing).

PREFACE

Standard Reference Materials (SRM's) as defined by the National Bureau of Standards are "well-characterized materials, produced in quantity, that calibrate a measurement system to assure compatibility of measurement in the nation." SRM's are widely used as primary standards in many diverse fields in science, industry, and technology, both within the United States and throughout the world. In many industries traceability of their quality control process to the national measurement system is carried out through the mechanism and use of SRM's. For many of the nation's scientists and technologists it is therefore of more than passing interest to know the details of the measurements made at NBS in arriving at the certified values of the SRM's produced. An NBS series of papers, of which this publication is a member, called the NBS Special Publication - 260 Series is reserved for this purpose.

This 260 Series is dedicated to the dissemination of information on all phases of the preparation, measurement, and certification of NBS-SRM's. In general, much more detail will be found in these papers than is generally allowed, or desirable, in scientific journal articles. This enables the user to assess the validity and accuracy of the measurement processes employed, to judge the statistical analysis, and to learn details of techniques and methods utilized for work entailing the greatest care and accuracy. It is also hoped that these papers will provide sufficient additional information not found on the certificate so that new applications in diverse fields not foreseen at the time the SRM was originally issued will be sought and found.

Inquiries concerning the technical content of this paper should be directed to the author(s). Other questions concerned with the availability, delivery, price, and so forth will receive prompt attention from:

Office of Standard Reference Materials
National Bureau of Standards
Washington, D.C. 20234

J. Paul Cali, Chief
Office of Standard Reference Materials

OTHER NBS PUBLICATIONS IN THIS SERIES

Catalog of NBS Standard Reference Materials (1975-76 edition), R. W. Seward, ed., NBS Spec. Publ. 260 (June 1975). \$1.50* SN003-003-01445-1

Michaelis, R. E., and Wyman, L. L., Standard Reference Materials: Preparation of White Cast Iron Spectrochemical Standards, NBS Misc. Publ. 260-1 (June 1964). COM74-11061**

Michaelis, R. E., Wyman, L. L., and Flitsch, R., Standard Reference Materials: Preparation of NBS Copper-Base Spectrochemical Standards, NBS Misc. Publ. 260-2 (October 1964). COM74-11063**

Michaelis, R. E., Yakowitz, H., and Moore, G. A., Standard Reference Materials: Metallographic Characterization of an NBS Spectrometric Low-Alloy Steel Standard, NBS Misc. Publ. 260-3 (October 1964). COM74-11060**

Hague, J. L., Mears, T. W., and Michaelis, R. E., Standard Reference Materials: Sources of Information, NBS Misc. Publ. 260-4 (February 1965). COM74-11059

Alvarez, R., and Flitsch, R., Standard Reference Materials: Accuracy of Solution X-Ray Spectrometric Analysis of Copper-Base Alloys, NBS Misc. Publ. 260-5 (March 1965). PB168068**

Shultz, J. I., Standard Reference Materials: Methods for the Chemical Analysis of White Cast Iron Standards, NBS Misc. Publ. 260-6 (July 1975). COM74-11068**

Bell, R. K., Standard Reference Materials: Methods for the Chemical Analysis of NBS Copper-Base Spectrochemical Standards, NBS Misc. Publ. 260-7 (October 1965). COM74-11067**

Richmond, M. S., Standard Reference Materials: Analysis of Uranium Concentrates at the National Bureau of Standards, NBS Misc. Publ. 260-8 (December 1965). COM74-11066**

Anspach, S. C., Cavallo, L. M., Garfinkel, S. B., Hutchinson, J. M. R., and Smith, C. N., Standard Reference Materials: Half Lives of Materials Used in the Preparation of Standard Reference Materials of Nineteen Radioactive Nuclides Issued by the National Bureau of Standards, NBS Misc. Publ. 260-9 (November 1965). COM74-11065**

Yakowitz, H., Vieth, D. L., Heinrich, K. F. J., and Michaelis, R. E., Standard Reference Materials: Homogeneity Characterization on NBS Spectrometric Standards II: Cartridge Brass and Low-Alloy Steel, NBS Misc. Publ. 260-10 (December 1965). COM74-11064**

Napolitano, A., and Hawkins, E. G., Standard Reference Materials: Viscosity of Standard Lead-Silica Glass, NBS Misc. Publ. 260-11 (November 1966). NBS Misc. Publ. 260-11**

Yakowitz, H., Vieth, D. L., and Michaelis, R. E., Standard Reference Materials: Homogeneity Characterization of NBS Spectrometric Standards III: White Cast Iron and Stainless Steel Powder Compact, NBS Misc. Publ. 260-12 (September 1966). NBS Misc. Publ. 260-12**

Spijkerman, J. I., Snediker, D. K., Ruegg, F. C., and DeVoe, J. R., Standard Reference Materials: Mossbauer Spectroscopy Standard for the Chemical Shift of Iron Compounds, NBS Misc. Publ. 260-13 (July 1967). NBS Misc. Publ. 260-13**

Menis, O., and Sterling, J. T., Standard Reference Materials: Determination of Oxygen in Ferrous Materials - SRM 1090, 1091, and 1092, NBS Misc. Publ. 260-14 (September 1966). NBS Misc. Publ. 260-14**

Passaglia, E., and Shouse, P. J., Standard Reference Materials: Recommended Method of Use of Standard Light-Sensitive Paper for Calibrating Carbon Arcs Used in Testing Textiles for Colorfastness to Light, NBS Misc. Publ. 260-15 (June 1967). (Replaced by NBS Spec. Publ. 260-41.)

Yakowitz, H., Michaelis, R. E., and Vieth, D. L., Standard Reference Materials: Homogeneity Characterization of NBS Spectrometric Standards IV: Preparation and Microprobe Characterization of W-20% MO Alloy Fabricated by Powder Metallurgical Methods, NBS Spec. Publ. 260-16 (January 1969). COM74-11062**

Catanzaro, E. J., Champion, C. E., Garner, E. L., Marinenko, G., Sappenfield, K. M., and Shields, W. R., Standard Reference Materials: Boric Acid; Isotopic and Assay Standard Reference Materials, NBS Spec. Publ. 260-17 (February 1970). Out of Print

Geller, S. B., Mantek, P. A., and Cleveland, N. G., Standard Reference Materials: Calibration of NBS Secondary Standard Magnetic Tape (Computer Amplitude Reference) Using the Reference Tape Amplitude Measurement "Process A," NBS Spec. Publ. 260-18 (November 1969). (See NBS Spec. Publ. 260-29.)

Paule, R. C., and Mandel, J., Standard Reference Materials: Analysis of Interlaboratory Measurements on the Vapor Pressure of Gold (Certification of Standard Reference Material 745), NBS Spec. Publ. 260-19 (January 1970). PB190071**

Paule, R. C., and Mandel, J., Standard Reference Materials: Analysis of Interlaboratory Measurements on the Vapor Pressures of Cadmium and Silver, NBS Spec. Publ. 260-21 (January 1971). COM74-11359**

Yakowitz, H., Fiori, C. E., and Michaelis, R. E., Standard Reference Materials: Homogeneity Characterization of Fe-3 Si Alloy, NBS Spec. Publ. 260-22 (February 1971). COM74-11357**

Napolitano, A., and Hawkins, E. G., Standard Reference Materials: Viscosity of a Standard Borosilicate Glass, NBS Spec. Publ. 260-23 (December 1970). COM71-00157**

Sappenfield, K. M., Marineko, G., and Hague, J. L., Standard Reference Materials: Comparison of Redox Standards, NBS Spec. Publ. 260-24 (January 1972). COM 72-50058**

Hicho, G. E., Yakowitz, H., Rasberry, S. D., and Michaelis, R. E., Standard Reference Materials: A Standard Reference Material Containing Nominally Four Percent Austenite, NBS Spec. Publ. 260-25 (February 1971). COM 74-11356**

Martin, J. F., Standard Reference Materials: National Bureau of Standards-US Steel Corporation Joint Program for Determining Oxygen and Nitrogen in Steel, NBS Spec. Publ. 260-26 (February 1971). 85 cents* SN003-003-00786-2

Garner, E. L., Machlan, L. A., and Shields, W. R., Standard Reference Materials: Uranium Isotopic Standard Reference Materials, NBS Spec. Publ. 260-27 (April 1971). COM74-11358**

Heinrich, K. F. J., Myklebust, R. L., Rasberry, S. D., and Michaelis, R. E., Standard Reference Materials: Preparation and Evaluation of SRM's 481 and 482 Gold-Silver and Gold-Copper Alloys for Microanalysis, NBS Spec. Publ. 260-28 (August 1971). COM71-50365**

Geller, S. B., Standard Reference Materials: Calibration of NBS Secondary Standard Magnetic Tape (Computer Amplitude Reference) Using the Reference Tape Amplitude Measurement "Process A-Model 2," NBS Spec. Publ. 260-29 (June 1971). COM71-50282**

Gorozhanina, R. S., Freedman, A. Y., and Shaievitch, A. B. (translated by M. C. Selby), Standard Reference Materials: Standard Samples Issued in the USSR (A Translation from the Russian), NBS Spec. Publ. 260-30 (June 1971). COM71-50283**

Hust, J. G., and Sparks, L. L., Standard Reference Materials: Thermal Conductivity of Electrolytic Iron SRM 734 from 4 to 300 K, NBS Spec. Publ. 260-31 (November 1971). COM71-50563**

Mavrodineanu, R., and Lazar, J. W., Standard Reference Materials: Standard Quartz Cuvettes, for High Accuracy Spectrophotometry, NBS Spec. Publ. 260-32 (December 1973). 55 cents* SN003-003-01213-1

Wagner, H. L., Standard Reference Materials: Comparison of Original and Supplemental SRM 705, Narrow Molecular Weight Distribution Polystyrene, NBS Spec. Publ. 260-33 (May 1972). COM72-50526**

Sparks, L. L., and Hust, J. G., Standard Reference Materials: Thermoelectric Voltage, NBS Spec. Publ. 260-34, (April 1972). COM72-50371**

Sparks, L. L., and Hust, J. G., Standard Reference Materials: Thermal Conductivity of Austenitic Stainless Steel, SRM 735 from 5 to 280 K, NBS Spec. Publ. 260-35 (April 1972.) 35 cents* COM72-50368**

Cali, J. P., Mandel, J., Moore, L. J., and Young, D. S., Standard Reference Materials: A Referee Method for the Determination of Calcium in Serum, NBS SRM 915, NBS Spec. Publ. 260-36 (May 1972). COM72-50527**

Shultz, J. I., Bell, R. K., Rains, T. C., and Menis, O., Standard Reference Materials: Methods of Analysis of NBS Clay Standards, NBS Spec. Publ. 260-37 (June 1972). COM72-50692**

Richmond, J. C., and Hsia, J. J., Standard Reference Materials: Preparation and Calibration of Standards of Spectral Specular Reflectance, NBS Spec. Publ. 260-38 (May 1972). COM72-50528**

Clark, A. F., Denson, V. A., Hust, J. G., and Powell, R. L., Standard Reference Materials: The Eddy Current Decay Method for Resistivity Characterization of High-Purity Metals, NBS Spec. Publ. 260-39 (May 1972). COM72-50529**

McAdie, H. G., Garn, P. D., and Menis, O., Standard Reference Materials: Selection of Thermal Analysis Temperature Standards Through a

Cooperative Study (SRM 758, 759, 760), NBS Spec. Publ. 260-40 (August 1972.) COM-72 50776**

Wood, L. A., and Shouse, P. J., Standard Reference Materials: Use of Standard Light-Sensitive Paper for Calibrating Carbon Arcs Used in Testing Textiles for Colorfastness to Light, NBS Spec. Publ. 260-41 (August 1972) COM72-50775**

Wagner, H. L., and Verdier, P. H., eds., Standard Reference Materials: The Characterization of Linear Polyethylene, SRM 1475, NBS Spec. Publ. 260-42 (September 1972). COM72-50944**

Yakowitz, H., Ruff, A. W., and Michaelis, R. E., Standard Reference Materials: Preparation and Homogeneity Characterization of an Austenitic Iron-Chromium-Nickel Alloy, NBS Spec. Publ. 260-43 (November 1972). COM73-50760**

Schooley, J. F., Soulen, R. J., Jr., and Evans, G. A., Jr., Standard Reference Materials: Preparation and Use of Superconductive Fixed Point Devices, SRM 767, NBS Spec. Publ. 260-44 (December 1972). COM73-50037**

Greifer, B., Maienthal, E. J., Rains, T. C., and Rasberry, S. D., Standard Reference Materials: Powdered Lead-Based Paint, SRM 1579, NBS Spec. Publ. 260-45 (March 1973). COM73-50226**

Hust, J. G., and Giarratano, P. J., Standard Reference Materials: Thermal Conductivity and Electrical Resistivity Standard Reference Materials: Austenitic Stainless Steel, SRM's 735 and 798, from 4 to 1200 K, NBS Spec. Publ. 260-46 (March 1975). SN003-003-01278-5

Hust, J. G., Standard Reference Materials: Electrical Resistivity of Electrolytic Iron, SRM 797, and Austenitic Stainless Steel, SRM 798, from 5 to 280 K, NBS Spec. Publ. 260-47 (February 1974). COM74-50176**

Mangum, B. W., and Wise, J. A., Standard Reference Materials: Description and Use of Precision Thermometers for the Clinical Laboratory, SRM 933 and SRM 934, NBS Spec. Publ. 260-48 (May 1974). 60 cents* SN003-003-01278-5

Carpenter, B. S., and Reimer, G. M., Standard Reference Materials: Calibrated Glass Standards for Fission Track Use, NBS Spec. Publ. 260-49 (November 1974). SN003-003-01344-7

Hust, J. G., and Giarratano, P. J., Standard Reference Materials: Thermal Conductivity and Electrical Resistivity Standard Reference Materials:

Electrolytic Iron, SRM's 734 and 797 from 4 to 1000 K, NBS Spec. Publ. 260-50 (June 1975) 1.00* SN003-003-01425-7

Mavrodineanu, R., and Baldwin, J. R., Standard Reference Materials: Glass Filters As a Standard Reference Material for Spectrophotometry Selection; Preparation; Certification; Use - SRM 930, NBS Spec. Publ. 260-51 (November 1975) \$1.90* SN003-003-01481-8

Hust, J. G., and Giarratano, P. J., Standard Reference Materials: Thermal Conductivity and Electrical Resistivity Standard Reference Material 730 and 799, from 4 to 3000 K, NBS Spec. Publ. 260-52 (September 1975). \$1.05* SN003-003-01464-8

Durst, R. A., Standard Reference Materials: Standardization of pH Measurements, NBS Spec. Publ. 260-53 (December 1975, Revised) \$1.05* SN003-003-01551-2

Burke, R. W., and Mavrodineanu, R., Standard Reference Materials: Certification and Use of Acidic Potassium Dichromate Solutions as an Ultraviolet Absorbance Standard, NBS Spec. Publ. 260-54 (August 1977). \$3.00* SN003-003-01828-7

Ditmars, D. A., Cezairliyan, A., Ishihara, S., and Douglas, T. B., Standard Reference Materials: Enthalpy and Heat Capacity; Molybdenum SRM 781, From 273 to 2800 K, NBS Spec. Publ. 260-55 (September 1977). \$2.20* SN003-003-01836-8

Powell, R. L., Sparks, L. L., and Hust, J. G., Standard Reference Materials: Standard Thermocouple Material, Pt.-67:SRM1967, NBS Spec. Publ. 260-56 (in press).

Cali, J. P. and Plebanski, T., Guide to United States Reference Materials, NBS Spec. Publ. 260-57 (in press).

* Send order with remittance to: Superintendent of Documents, US Government Printing Office, Washington, DC 20402. Remittance from foreign countries should include an additional one-fourth of the purchase price for postage.

** May be ordered from: National Technical Information Services (NTIS), Springfield, Virginia 22151.

TABLE OF CONTENTS

Standard Reference Materials:
GUIDE TO UNITED STATES REFERENCE MATERIALS

J. Paul Cali
Office of Standard Reference Materials
Institute for Materials Research
National Bureau of Standards
Washington, D.C. 20234

and

Tomasz Plebanski
Polish Committee of Standardization
and Measures
Warsaw, Poland

Summarized is a list of reference materials produced and distributed by U.S. manufacturers, both public and private. Extensive tables are indexed by use to which reference materials may be put. Properties covered include: chemical composition (analytical chemical purposes), chemical composition (high purity), physical properties, engineering and technological properties, and biochemical properties. Names and addresses of 93 U.S. producers and/or distributors are included.

Key words: Measurement; reference materials; standardization; Standard Reference Materials.

GUIDE TO UNITED STATES REFERENCE MATERIALS

I. Background

In 1976, the Council Committee on Reference Materials (REMCO) of the International Organization for Standardization proposed as the term "reference materials" the following definition: "A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus or for the verification of a measurement method." "A certified reference material (CRM) is further defined as: "A RM accompanied by, or traceable to, a certificate stating the property value(s) concerned, issued by an organization, public or private, which is generally accepted as technically competent." A careful reading of this definition will lead the reader to the conclusion that a great many materials will rest comfortably under its umbrella. Thus, for an analytical chemist any pure chemical used to prepare what are usually called "standard solutions" can be considered to be a reference material. Simple devices, such as accurately calibrated optical filters, also are covered by this definition. Where to draw the line to exclude various chemicals or devices is somewhat arbitrary and no hard and fast rules have been developed to date. Weights used to calibrate or check balances are, e.g., not considered reference materials, even though they obviously fit the definition very well. For this reason then the reference materials listed herein are somewhat arbitrary. In fact, the inclusion or exclusion of a particular supplier's reference materials is first and foremost simply a function of whether or not he replied to our inquiry for information.

The current great interest in reference materials as an important means for helping to assure measurement compatibility in a wide variety of applications dates from 1969. In that year the National Bureau of Standards (NBS) and the International Committee on Weights and Measures (CIPM) cosponsored a meeting where the desirability of establishing a formal program internationally was explored. Representatives from 15 countries and 4 international agencies agreed unanimously that such a course of action would be desirable. The need for a central distributing agency for exchange of information on reference materials, preferably through an international agency was stressed. The CIPM was asked to assume this (and other) responsibilities. Subsequently however, the CIPM with regret had to decline due to a lack of resources and a misfit with regard to its scope. (1)

However, the matter was not dead for following the first large scale SRM Symposium held at NBS in 1973 - see reference (2), a meeting called by the International Organization for Legal Metrology was held to reactivate the matter. As a result of this meeting, attended by representatives of 12 countries and 7 international agencies, ISO subsequently agreed to provide secretariat services for international agencies interested in the exchange of information concerning reference materials.

Thus, ISO established REMCO in 1974 to coordinate reference material information exchange activities. Since one of the authors (J. P. Cali) is the U.S.-American National Standards Institute (ANSI) representative on REMCO, this report was prepared to provide information on reference material activity and availability in the U.S. for dissemination in international channels, as well as information of value to U.S. science, technology, and industry directly.

The other author (T. Plebanski) spent one year at NBS under a UNESCO fellowship studying RM's. With this work in place he helped gather, collate, and prepare for publication information on U.S. available reference materials. To this end, NBS contracted with him in 1974 to perform these functions.

II. Purpose of Guide

All measurement networks need to be compatible. By this we mean that producer and consumer, or regulator and those regulated, need to be able to measure the property(ies) of the same sample in such a way that, within agreed on limits of uncertainty, all obtain identical numerical values of the property(ies) under measurement. Cali, among others, has shown (see 3 or 4 e.g.) that when measurement systems are based on accuracy that measurement compatibility must logically ensue. However, to achieve accuracy in measurement, especially when the property under consideration is that of composition, five basic components of the measuring process need to be available or present (see, e.g., 5). One of these is reference materials and called at NBS for historical reasons Standard Reference Materials (SRM).

Thus, a knowledge of where to obtain reference materials is important. This then is the basic rationale and principal purpose for this guide.

III. Scope and Structure of Guide

Listed in the body of the report are over 17,000 reference materials. Of these approximately 7,200 fall into

the class "certified reference materials" (see Section IV, below). These 17,000 reference materials are either the direct product of or are distributed by the 93 U.S. companies and/or organizations who responded to the NBS request for information. The information supplied was primarily in the form of catalogues, product lists, etc.

Of the 17,000 reference materials listed, about 2,000 are produced in foreign countries, principally Japan and countries of Europe. There is, of course, considerable duplication among the reference materials. The duplication is especially strong in these classes: high purity elements and inorganic chemicals; spectrochemical mixtures, powders, and alloys; and, standard solutions and mixtures for atomic absorption calibration. We estimate there are listed approximately 10,000 different reference materials produced in the U.S.

No attempt has been made to make a quality assessment of either the producers or of their reference materials.

Two classes of reference materials have been listed: general reference materials (RM) and certified reference materials (CRM). These have been defined above. In attempting to decide whether a particular material was, in fact, suitable for use as a reference material, the general criteria listed by Cali in reference 6 were applied. Some of these criteria are: purity, homogeneity, stability, continuity of both supply and information, availability, and extent of certification process. Other factors considered were: (1) whether the producer states in his literature that his product is suitable for reference purposes (as calibrating material, e.g.); (2) whether the producer guarantees his product in some meaningful way; (3) whether useful technical information is supplied with his product (e.g., actual lot analysis); (4) by comparison of the same product from different sources; and/or, (5) by some evidence that traceability to national or international standards has been established. Thus, it is apparent that a considerable degree of subjective judgment was used by the authors. The ultimate test, of course, as to whether a particular material can serve usefully as a reference material must lie with the user.

The properties embodied in the reference materials are classified in five categories:

1. Chemical composition (Analytical RM) - multicomponent (usually) reference materials, often mixtures or solutions, used in chemical analytical systems. This class will include alloys, mixtures, natural materials, etc.

2. Chemical composition (High Purity RM) - single component (usually) reference materials of high purity used in chemical analytical systems. However, they may also serve for the realization or determination of other properties, e.g., physico-chemical, thermochemical, electrical, etc. Others, e.g., platinum, cesium, kryton serve as primary RM in defining international scales. These latter RM are certified for total purity of the main component and for trace impurities present.
3. Physical properties - reference materials characterized for optical, heat, radiation, etc. properties.
4. Engineering and technological properties - reference materials embodying properties as hardness, smoke density, etc.
5. Biochemical properties - reference materials of botanical, biological, clinical, bionuclear substances.

These categories are not necessarily mutually exclusive. Often RM's will be characterized for more than one property and thus will be found in the appropriate categories. E.g., some bionuclear RM's might be found in category(ies) 1, 3, and 5 if characterized for chemical composition, radioactivity, and biological activity.

Two tables are presented:

Table A: Index of Reference Materials. In this table are incorporated both matrices and properties of interest arranged in the five categories listed above. It would have been impractical to list individually every RM by chemical name or specific material. Therefore, we have tried to use classes or groups to lead the user to a supplier who can provide more specific information with regard to highly specific chemicals, matrices, or properties. In other words, the principal utility of this listing is to provide general guidance to the user to assist in shortening his search time and to make him aware of RM supplies he might otherwise have missed. Only in the catalogs of the various suppliers will be found the specific information usually required for the ultimate end-use.

Table B: Index of Suppliers. In this table we give the names and addresses of the suppliers who replied to our request for information. The addresses shown are those given by the supplier at the time his catalogues were delivered to NBS. Each is given a supplier number, an internal NBS file number, and the approximate number of RM's, either general or certified, produced or distributed.

IV. Disclaimer

In issuing this guide NBS makes no warranty, explicit or implied, that any RM listed will perform or not as claimed by the producer or distributor.[†] Neither does NBS, through the inclusion or exclusion of any RM producer or distributor, impute either directly or indirectly the technical, scientific, or economic value or worth of the RM's referenced. This guide is issued by NBS for information only to provide RM users or potential users to RM sources in the U.S. NBS, an agency of the U.S. Government, assumes no liability for damages resulting from the use or misuse of any of the information given in the guide or from use or misuse of the RM's referenced.

V. Updating of Guide

It is our intention to update the guide from time to time as interest and demand warrant. RM producers, suppliers, and distributors may send catalogues and pertinent information, together with suggestions to improve the usefulness of the guide to:

J. Paul Cali
Chief, Office of Standard
Reference Materials
Institute for Materials Research
National Bureau of Standards
Washington, D.C. 20234.

[†]Excepting RM's and CRM's directly produced by NBS itself (Supplier #86).

A. INDEX OF REFERENCE MATERIALS

Category 1: Chemical Composition - Analytical Reference Materials

		<u>Supplier No.</u>
Air - See gases Category 1		
Air particulate analysis		25
Alcohols--gas chromatography		62
Alloys - ferrous chemical		16, 19, 43, 48, 72, 73, 86, 91
- ferrous spectrochemical		4, 10, 16, 19, 32, 43, 48, 72, 73, 86, 89, 91
- ferrous, specific for:		
C and S content		38, 48
ferroalloys		19
gases in		48, 86
iron		4, 10, 16, 19, 86
pure iron		10, 38
slags		4, 16, 19
steels		4, 16, 19, 32, 86, 89
teaching students		72
calibration of optical emission and x-ray fluorescence spectrometers		86, 89 16, 19, 43, 73
- ferrous (non-US origin)		16, 19, 39, 43, 48, 72, 73, 86, 91
- nonferrous chemical		4, 5, 12, 16, 19, 32, 40, 43, 48, 56 72, 73, 86, 91
- nonferrous spectrochemical		5, 12, 56, 86 86 39 4, 56, 86 5, 86
- nonferrous, specific for:		
aluminum		
copper		
gold		
lead		
magnesium		

nickel	4, 19, 32, 40, 86
silver	4, 39
tin	4, 56, 86
zinc	12, 56, 86
teaching students	72
- nonferrous, (non-US origin)	16, 19, 43, 73
Analytical primary standards	37, 44, 72, 86
Aroclor - solutions of PCB's	13
- see also polychlorobiphenyls; Categories 1 and 2	
Atomic absorption - mixtures and solutions	4, 14, 18, 19, 29, 33, 43, 44, 47, 54, 73, 91
- aqueous	4, 14, 18, 19, 33, 47, 54, 73, 91
- aqueous, trace metals	4
- nonaqueous	14, 27, 29, 33, 43, 54, 73, 91
Blends/hydrocarbon	61, 86
Buffers/organic	29
Carbides	86
Carbon in steel - calibration samples; see also alloys, ferrous	48
Category 1	
Cements	86
Ceramics	19, 49
Chelometry	44
Chlorine in lubricating oil	10
Chromatography	20, 31, 44, 53
- polystyrene polymers	28
- see also gas chromatography; Category 1	
Clinical - see also clinical in Category 5	44, 86
Coal	48, 86
Coke	19, 48
Cryolite - Greenland natural and synthetic	5
Diesel fuel - contaminant standard series	54
- reference fuel	61
- sulfur in	10

Dolomite	37
Dunite dilute - pitchblendé	85
- monazite	85
Dye test mixture	31
Ebony manganese	34
Electron probe-microanalytical	78, 86
Elements - listed in Category 2	
Elements in graphite	
Environmental - gases	
- hazards	
Esters, gas chromatography	
Feldspar	62
Flame emission spectroscopy	73
Fluors, primary	53
Fuels	62
Fuel oil, residual, sulfur in	55
Gas chromatography	55
- solvents for	61
Gases	86
- see also Categories 2, 3 and 4	86
- dopant mixtures	2
- environmental	3, 86
- for chromatography	44
- gaseous blends, synthetic mixtures	61
- helium mixtures	87
- hydrocarbons	61
- in metals	48, 73, 86
- lung diffusion mixtures	2
- mixtures, two and multicomponent	2, 3, 13, 44, 68, 86, 87
- moisture mixtures	3
- primary gravimetric mixtures	3, 68, 87
Gasoline - sulfur in	10
- see also fuels in Category 4	
Glasses - trace elements in	86
Graphite, impurities in	73
Hastalloy	32

Helium - crude mixtures.	87
- in neon	2
- primary gravimetric mixtures.	87
- secondary partial pressure mixtures	87
- with added components	87
Hydrazines - environmental contaminants.	53
Hydrocarbons - blends.	86
- for gas chromatography.	62
- mixtures.	61, 74
Hydrogen in steel and titanium	48
Inconel alloys	4, 32, 40
Incloy alloys	40
Indicators	44
Insecticides - see Category 2	
Ionic metal standards.	44
Ionization and releasing agents.	33
Ion selective electrodes - see Category 3	
Iron - see ferrous alloys in Category 1 and elements in Category 2	
Kerosene - sulfur in	10
- see also fuels in Category 4	
Ketones for gas chromatography	62
Limestone.	37
Lube oil - sulfur and chlorine in.	10
Magnetite.	34
Metallurgy - for electron probe x-ray microanalysis.	72, 86
- see also alloys in Category 1	
Metals - for electronics, see Category 4	
- gases in.	48, 73, 86
- in drinking water	4
- ionic standards	44
- see also elements in Category 2 and alloys in Category 1	
Metallorganic compounds in liquid organic solutions.	10, 14, 27, 29, 33,
Microanalytical.	43, 54, 73, 91
	37, 44, 86

Minerals, ores and rocks.	5, 19, 34, 37, 72, 78, 85, 86
Mixes for spectrography	73
Monasite.	85
Monel alloys.	4, 32, 40
Monene hydrocarbon mixtures.	74
Nitrogen - see gases in metals	Category 1, and gases in Categories 1 and 2
Nobel metals - alloys and spectrographic mixtures	39, 73
Nuclear materials - chemical composition.	86
Oxidation reagents.	55
Ores - see minerals in Category 1	
Oxygen - see gases Category 1 and 2, and gases in metals Category 1	
Paraffin mixtures for retention indices.	74
Pesticides - mixtures, kits	13, 28, 53, 62, 74, 82
- residue analysis	53
- see also Category 2	
Phenols for gas chromatography.	62
Pitchblend	85
Pollution - emission control gases.	2, 3
- sulfur in oils and fuels.	10, 48, 86
- syringeable standards	53
Polychlorinated biphenyls (PCB)	13, 28, 53
Powder mixtures for spectrography	43, 73, 88
Rare earth - spectrographic mixtures.	73
Refractories.	86
Rocks - see minerals in Category 1	
Sandspot.	34
Scintillators - premixed.	55
- see also scintillation and scintillators in Category 3	
Sevin - carbaryl insecticide.	82
Sieve analysis - glass spheres.	86
Sinters.	19
Slags.	19
Spectrophotometry - reference substances for.	
- see also spectroscopy in Category 3	

Spectrography.	43, 44, 73, 81, 85
- see also spectroscopy in Category 3	88
- see also alloys, spectrochemical in Category 1	
Spectrographic solvents.	21, 61
Spectrum shifters.	55
Spodumene.	34
Steels - see ferrous alloys in Category 1	
Steroid mixtures	74
Sulfur in coal	48, 86
- coke	48
- diesel fuel.	10
- fuel oil	10
- gasoline	10
- kerosene	10
- lube oil	10
- steel.	48
Sulfur hydrocarbons.	48
Synthetic organic mixtures	61
Syringeable standards for gas chromatography of environmental hazards.	
Teaching students - alloys	53
- commercial products	72
- primary standards.	72
- rocks and ores	72
Titrants	29, 37
Trace element detecting kits	1, 4
Waspalloy.	32
Water - oxygen 18 and 17 enriched	51
- testing.	47
- trace metals in.	4
- waste water.	4

Category 2: Chemical Composition - High Purity Reference Materials

	<u>Supplier No.</u>
Acidimetric substances.	37, 44
Acids, dicarboxylic	62
Actinide metal halides.	64
Alkaloids for chromatography.	31
Alcohols.	62
Alkali metal halides.	64
Alkaline earth metal halides.	64
Amines.	53, 62
Antimicrobials.	62
Antioxidants.	53, 62
Atomic absorption, see also Category 1.	44
Benzil.	14
Benzoic acid.	14
Boride ceramic powders.	49
Carbide ceramic powders	49
Carbon.	15
- spectrographic	15, 80, 81
Carcinogens - environmental hazards	53
Chelometric substances.	44
Elements/including metals.	7, 11, 15, 18, 19, 26, 30, 34, 35, 38, 43, 44, 45, 49, 50, 64, 71, 73, 86, 88, 90, 91
- full assortment of 5N and 6N pure standards.	7, 11, 15, 18, 30, 35, 44, 45, 49, 50
- crystals for spectrophotometry	18
- for electronics.	26, 30, 50, 88
- in various forms: rods, ingots, shots, powders, wires, sheets, foils, single crystals, sputtering targets, vapor deposition, flakes, chips, granules.	15, 26, 30, 45, 49, 50, 90, 91

- specific:

gallium.	64
germanium.	64
gold.	86
iron.	10, 38
lithium.	34
platinum	71
silicon-9N pure.	15, 64
zinc	86
 Esters	 62
Ferrites	49
Fertilizers.	86
Fixatives for electron microscopy made from ultrapure chemicals.	78
Gallium arsenide	52
Gases - environmental.	2, 3, 86
- individual, highest purity.	2, 3, 68, 86
- Kr-85	2
- research	2, 3, 68
- tritium	2
Glycosides for chromatography.	31
Graphite	15
- spectrographic.	15, 36, 80, 81
Halides	64
Helium - various specifications	87
Hydrazines - environmental contaminants.	53
Hydrocarbons	6, 53, 61, 62, 74
- polynuclear for chromatography.	23, 53
Inorganic compounds.	11, 15, 26, 30, 34,
	35, 43, 44, 46, 49,
	50, 63, 64, 73, 85,
	86, 91
Insecticides	23, 82
Ionic metals	44
Iron	10, 38
Lanthanide metal halides	64

Lithium metal, natural isotopic composition	34
Metallorganics, see also Category 1.	11, 73, 86, 91
- for electronics	91
Microchemicals	44, 86
Monoene hydrocarbons	74
Mutagens - environmental hazards for chromatography	53
Nitroamines - environmental contaminants	53
Nitrogen compounds - organic	6, 53
Nitride ceramic powders.	49
Noble metals	71
Organic compounds/general.	4, 6, 21, 23, 30, 44, 53, 61, 62, 86
Oxides	49, 63
Pesticides, see also Category 1.	4, 13, 23, 53, 62
	82
Phenols.	62
Polychlorobiphenyls - environmental hazards.	53
Polynuclear hydrocarbons, environmental hazards.	53
- nitrogen compounds, environmental hazards	53
Precious metal halides	64
Primary standards for chemical analysis	37, 44, 72, 86
Purines.	23
Pyrimidines.	23
Quartz/various forms	67
Rare earth - fluorides	63
- halides	64
- oxides.	63
- sulfates.	63
- single crystals	50
- see also inorganics in Category 2	49
Rare earths - see elements in Category 2	15, 64
Seed crystals, metals	52, 75
Silicide ceramic powders	21, 29, 44
Silicon - 9N pure.	
- other	
Solvents for gas chromatography and spectrophotometry.	

- for spectrography.
- organic solvents "distilled in glass" for numerous instrumental techniques 21
- Sulfides. 62
- Sulfur compounds - organic. 6
- Teratogens - environmental hazards. 53
- Titanates - zirconates, ceramic powders 49
- Titrants. 37
- Transition metal halides. 64
- Vanadium chemicals. 34
- Vitride - reducing agent. 29

Category 3: Physical Property Reference Materials

	<u>Supplier No.</u>
Acidimetry.	37, 44
Alpha reference sources	8, 41, 55
Asphalt viscosity standards	24
Atomic absorption - wavelength.	18, 33, 73, 92
- see also hollow cathode and cathodeon in Category 4	
- flame standards for	44
- pure solvents for.	21
Beta-reference sources.	8, 41, 55
- standard radionuclide solutions	41
C-13, NMR reference	9
Cadmium mercury telluride - IR detector	26
Californium-252, fission fragment sources	8
Calorimetry	6, 86
Chromatography, see Category 1	
Colorimetry	35, 37
Colors.	86
Colored glass filters for spectrophotometry	30
- see also absorption spectroscopy (Category 3), and also filters (Category 4)	
Combustion.	6

Conversion electron sources	8
Counting equipment/nuclear/calibration.	85
Cryometry - hydrocarbons suitable for comparative cryometric measurements.	6
Decoupling - NMR reference.	9
Density of liquids.	6, 85, 86
- solids	86
Deposits on filters - X-ray calibration	25
Deuterated NMR chemicals.	60
Dielectric-constant	66
- fluids	66
- loss	66
- solids	66
Diffraction - Mossbauer X-ray	86
Diffractometry.	25
Dimensions - glass spheres.	28, 86
- molecular sieves	64, 83
- membranes with precise pore geometry	58
- particle size.	28
- particulate standards	25
- see also sizing, Category 4	
Elasticity.	86
EDTA titrations	37
Electron microscopy, Category 4	
Electron probe, Category 4	
Electron spectrometry - calibration	55
Electrophoresis	17
Emissance/spectral.	86
Flame emission spectroscopy	33, 44, 54, 73
Flood sources/nuclear	55
Freezing - fixed temperature points	86
Gamma sources	8, 41, 55
- standardized solutions	41
Gas chromatography, Category 1	
Gases - calibration of instrumentation.	2, 3, 13, 44, 68, 86, 87

- deuterated	2
- gravimetric mixtures	2
- Kr-85 and tritium mixtures	2
- radioactive mixtures	2
- stable isotopes	2
Hardness, Category 4.	70
Heat.	86
Immunodiffusion	17
Immunoelectrophoresis - varieties of:	17
line, counter, double, crossed, crossed line, intermediate.	17
Infrared - crystals	33, 42, 93
- detectors	26, 76
- interference filters	42
- light emitters	52
- phosphors.	29
Interference filters.	42
Interferometry - multilayer interference films for.	30
Internal reflection	42, 93
Iodine-125 and other simulated sources.	55
Ion - activity.	47, 69, 77, 86
- selective electrodes calibration	47, 69, 86
- solutions Cl, Br, Cu, I.	69, 77
Ion chamber - detectors, gamma reference sets	55
- standard sources	41
Isotopes.	2, 8, 41, 51, 60,
	84, 86
Isotopes stable C-13, H-2, O-17, O-18, N-15.	41
Labeled compounds C-14, C-13, N-15, H-2, H-3.	13, 23, 41, 55
Magnetic susceptibility	86
Mass spectrometry	73
- solvents for	21
Medicine - nuclear RM's for	8, 23, 41, 44
Melting points.	86
Microscopy.	28
Microwave materials	76
Molecular weight.	14, 28, 86

Mössbauer - sources	8
- x-ray diffraction.	86
N-15 NMR reference.	9
Nephelometry - immunoglobulin fraction standards	17
Neutral glass filters for spectrophotometry	30, 86
Neutron sources	8
NMR - calibration	9, 44
- C-13 reference	9
- decoupling	9
- deuterated chemicals	60
- miscellaneous.	60
- N-15 reference	9
- parameters set up standards.	9
- proton reference	9, 57, 60
- resolution	9
- sensitivity.	9
- shift.	60, 91
- temperature.	9
Nuclear radiation detectors	76
Nuclides - radioactive.	41
Optical crystals, also Category 4	18, 76
Optical emission - see spectroscopy in Category 3 and alloys	
spectrochemical in Category 1	
Ores for calibrating nuclear counting equipment	85
Osmometry	14
Oxygen-18 and -17 enriched water	51
Partial pressure - He mixtures.	87
Particle size - polystyrene, aluminum, carbon black, iron oxide, silica.	28
Particulate standards - mineral deposits for calibration of X-ray diffractometers	25
Permittivity - see also dielectric constant in Category 3	86
pD.	86
pH.	44, 69, 77, 86
Photoconductivity	76
Photopolymerization/acrylamide.	17
Photovoltaic materials.	76

5	28, 61, 86
Polymer standards	14, 86
Polymers - molecular weight	14
- polyethylene	14
- polyester.	14
- polystyrene.	14, 28
- polyvinyl chloride	14
Positron sources	8
Proton - NMR reference.	9, 57, 60
Quartz - bars for monolithic filters.	67
- plates reproducing dielectric constant and loss.	66
Quenched or unquenched scintillation counting	41
Radioactive particle tracing - particle size standards.	28
Radioactive solutions	55
Radiochemicals.	8, 13, 86
Radioisotope assay calibration standards.	55
Radioisotope labeled compounds.	41
Radionuclides	41, 55
Redox titrimetry.	37
Reflectance	29, 86
Refractive index.	6, 65, 86
Resistivity	86
Resolution - NMR reference.	9
Retention indices	74
Scintillation - cameras checking.	55
- counting/liquid.	8, 21, 41, 44, 55
- phosphors, nuclear radiation detectors	76
- scintillators.	41, 55
Shift - NMR reagents.	60, 91
- spectrum shifters.	55
Simulated standards	41
Spectroscopy - calibration and selected physical property reference materials: filters, plates, crystals, emitters, detectors, etc.	8, 14, 18, 21, 29, 30, 33, 42, 43, 44, 52, 55, 61, 73, 76, 81, 86, 88, 89, 93

- absorption spectroscopy	18, 29, 30, 33, 42,
- emission spectroscopy	43, 44, 52, 86, 93
Category 1: alloys spectrochemical, atomic absorption, flame emission, metallorganics, mixes, spectrography	8, 14, 21, 30, 43,
Category 2: carbon, elements, graphite, inorganics, metallorganics, solvents	44, 55, 61, 73, 81, 86, 88, 89
- for specific information see the following key words in:	
Category 1: alloys spectrochemical, atomic absorption, flame emission, metallorganics, mixes, spectrography	
Category 2: carbon, elements, graphite, inorganics, metallorganics, solvents	
Category 3: electron spectrometry, flame emission, infrared, NMR, X-ray	
Category 4: crystals, electrodes, detectors, emitters, filters, infrared, wear metals in oil	86
Temperature - fixed points reproducing IPTS-68/75.	9
- NMR reference	9
Thickness (coating)	79, 86
Titrimetry	29, 37
Transmission	42, 93
Transmission sources (nuclear)	55
Tritium labeled compounds	13, 23, 41, 55
Turbidimetry	86
Uranium isotopic working standards	84
UV - crystals for spectroscopy	42
- interference filters	42
Viscosity - standards	24, 86
- asphalt	24
- glass	86
- polystyrene	28
Visible interference filters	42
Visocolor - test kits f. visual colorimetry	35
Volume (micro)	1
Volumetric analyses - primary standards, also Category 2	37
Wavelength	18, 73, 86, 92, 93

X-ray fluorescence analysis, see also spectroscopy in Category 3 and alloys in Category 1.	10, 21, 41, 89
X-ray - analytical standards.	73, 86
- calibration by using deposits on filters	25
- filters.	30
- fluorescence source.	41
- sources.	8, 41
- spectrometer analyzing crystals.	78
- variable energy sources.	8

Category 4: Engineering and Technical Property Reference Materials

Aluminum - particle size.	28
Asbestos - fiber reference standards.	28
ASTM - knock test reference fuel.	61
- blends of ASTM reference fuels	61
- naphthas (test fluids)	61
Aviation check fuels.	61
Burets (micro) - volume standards	1
Calibration fluids.	61
Carbon black - particle size.	28
Carbon for spectrography and electrodes	15, 80, 81
Carbon foils f. nuclear physics and electron microscopy	30
Cathodeon - atomic absorption hollow cathode lamps.	73
Cellophane (gel) membranes for osmometry.	14
cellulose (-deacetylated acetyl) membranes for osmometry	14
centrifugation - gradient medium	35
Ceramic powders	49
Coating thickness	86
Color charts.	86
Corning filters	43
Crystal quartz (cultured)	67
Crystals.	18, 29, 33, 42, 49
-	76, 78, 93
- for spectroscopy	18, 33, 42, 93

Deposits on filters for x-ray calibration and diffractometry	25
Detectors - nuclear radiation	76
- miscellaneous	55, 59
- spectroscopy	26, 76
Developers	43
Diesel - oil contaminants	10, 54
- reference fuel	61
Diode material	52
Discharge devices for atomic absorption	92
Electrodes and rods (carbon and graphite) for spectrography:	
counter, cupped (Harvey and Scribner-Mullins type), porous,	
rotating disc	15, 36, 43, 80
Electrodes - silver for vacuum spectrometry	81, 88
Electron microscopy	88
- carbon foils	44, 78, 80
- fixatives	30
- graphite and carbon ultrarods	78
- stains	80
Electron probe	78
Electronic grade gases for semiconductor industry	78, 86
Electronics - organometallics for	3
- chemicals and metals for	91
- alloys for	26, 30, 88
- electro-optic modulators for laser technique	26
Emission control gases	76
Emitters of infrared light	3
Filters - optical	52
- filtration checking - particle size standards	30, 42, 43, 67, 86
Flame standards for atomic absorption	28
Flammability (surface)	44
Flash point check fluids	86
Fuels - chlorine in	61
- sulfur in	10
- special to meet any desired specifications	10, 61, 86

Gallium - phosphides, arsenides, etc., for semiconductor and optoelectronic industry	49, 50, 52
Garnets - microwave materials	76
Gases - electronic for semiconductor industry	3
- emission control	3
- helium in neon spark chamber mixtures	2
- instrument	2, 3
- laser mixtures	2
- leak detection	2
- nuclear counter.	2
- see also gases in Categories 1, 2, and 3	
Glass	86
Glass spheres - particle size	28, 86
Graphite - spectroscopy rods, preformed electrodes, powders, etc.	15, 36, 43, 73, 80, 81, 88
- treated to meet customer specifications	80
Hardness.	70
Hollow cathode f. atomic absorption (wavelength standards)	18, 33, 73, 92
Indium antimonide with complete electrical specification	26
Indium phosphide - semiconductors	50
Infrared - crystals	33, 42, 93
- detectors.	26, 76
- filters.	30, 42, 43
- light emitters	52
Iron oxide - particle size.	28
Kodak filters	43
Laser - dyes.	29
- gas mixtures	2
- interference filters	42
- IR phosphors	29
- Q-switching.	29, 76
- technique and materials.	26, 76
- transmission windows	42
Leak detection gas mixtures	2
Light sensitive materials	86
Light dividers - multilayer interference films.	30

Liquid crystals for GC, NMR, etc.	29
Magnetic tapes	86
Membranes - for osmometry	14
- with precise pore geometry	58
- with imprinted grid pattern	58
- implant	58
- rectangular	58
Metrizamide - gradient medium for centrifuge	35
Moisture - gaseous mixtures	3
Molecular sieves	64, 83
Naphthas - ASTM test fluids	61
National marked spectroscopic carbon and graphite electrodes	36, 43, 81
Nitrobenzene - electronic grade	29
Nuclear counter - gas mixtures	2
Oils - calibration multielement spectroscopy standard	14
- chlorine in.	10
- sulfur in.	10
- wear metals in	14, 33, 43, 54,
Optical quality metal halides	73, 91
Optoelectronic materials	64
Osmometry - membranes for	49, 50, 52, 76
Paper - internal tearing resistance	14
Particulate and spiked particulate standards (deposits) for x-ray calibration and diffractometry	86
Petroleum ethers - test fluids	25
Phosphorous	61
Photographic materials	29, 30
Phthalocyanine compounds for laser Q-switching	86
Pollution, see Category 1	29
Polymers reference standards	61, 86
Polystyrene - monosized uniform and fluorescent microspheres	28
Pyrobond-silicon carbide graphite conversion	80
Pyrolytic graphite coated graphite	80
Q-switches for laser technique	29, 76
Quartz - cultured	67

Respiratory studies - lung diffusion mixtures	2
- particle size standards.	28
Rockwell hardness	70
Rubber - compounding materials	86
- swelling test fluids	61
Semiconductors.	50, 52
Silica - particle size.	28
Silicon for power and signal devices of semiconductor industry.	52
Silicon carbide coated graphite for epitaxial susceptors	80
Single crystals - organic	30
- see also elements in Category 2	
Sizing - membranes with precise pore geometry	58
- glass spheres.	28, 86
- molecular sieves	64, 83
- particle size standards.	28
- particulate samples.	25
Smoke density	86
Solvents - see Category 2	
Spectral sterilizers.	29
Sputtering targets.	50
- see also elements in Category 2	
Strips impregnated for air particulate analysis	25
Superconductive thermometric fixed point device	86
Surface flammability.	86
Test fluids	61
Turbidimetry.	86
Vapor deposition metals	50
Water vapor permeance	86
Wear metals (metallorganics) in lubricating oil	14, 33, 43, 54,
- windows - crystal	73, 91
- X-ray sensitive materials	18, 42
	86

Category 5: Biochemical Reference Materials (including biological, bionuclear, clinical, drug and medical reference materials)

	<u>Supplier No.</u>
Agarose	17
Aminoacids	20, 23, 31, 41
Aminosugars	41
Antibodies	17, 22
Antisera.	41
Barbiturates.	13
Biochemicals conforming to NAS/NRC specifications	22, 44
Biological samples - reference electron probe standards	78
Blood cell counting and sizing - particle size standards	28
Bovine liver - analytical standard.	86
Brain cerebroside hydrolyzates.	13
Buffers	17, 41
Carbohydrates	13
Cholesterol	86
Cholestryl esters.	13
Chromatography	20
Clinical.	13, 22, 44, 86
DNA	41
Drugs	13, 20, 23
Electron probe x-ray biological standards	78
Electron microscopy of biological materials	78
Electrophoresis	17
Ester Kits.	13
Fat and oil reference mixtures.	13, 74
Fatty acids - kits of	13, 41
- methyl esters.	74
- methyl esters for gas chromatography	13
Fatty alcohols.	13
Fixatives for electron microscopy	78
Fluorescent labeling.	17, 41
Glutaraldehyde for electron microscopy of biological materials	78

Growth factor analogs	41
Immunoassay	17, 55
Immunochemicals - standards for chromatography	22
Immunodiffusion	17
Immunoelectrophoresis	17
Immunoglobulin	17
Immunohistochemicals	41
Insecticides, see Category 2	
Iodine high intensity gamma sources - calibration standards for radioimmunoassay	55
Jenden reagent	13
Labeled biocompounds, see also Category 3	23,
Lecithin	13
Lourell buffer	17
Nucleosides	23
Nucleotides	23
Nuclear medicine - materials certified in μ Ci	8
- isotopes	8
ODD carbon	13
Oil reference mixtures (AOCS)	13
Orchard leaves	86
Osmium tetroxide for electron microscopy of biological materials	78
Pesticides, see Categories 1 and 2	
Phospholipids	13
Photopolymerization	17
Platinum thymine and platinum uracil blue - stains staining genetic materials	78
Prostaglandins	13
Protein labeling mixtures (C-14 and H-3)	55
Radiochemicals	13
Radioimmunoassay	17, 55
Simulated sources for medicine	55
Snake venoms	41

Stains (biological)	17, 41, 60, 78
- for electron microscopy.	78
- for fluorescent microscopy	60
Steroids.	13, 23, 55, 74
Svendsen buffer	17
Sugars.	20, 31
Sugar alcohols.	20, 31, 41
Triglycerides	13
Triolein.	13
Tritium labelled compounds	13, 23, 41, 55
UV enzymatic reagents	22
Vitamins.	20, 31, 41

B. INDEX OF SUPPLIERS

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>RM's</u>
1	72/97	Ace Scientific Supply Co., Inc. 1420 East Linden Avenue Linden, N. J. 07036	16	
2	72/88	Airco Industrial Gases 575 Mountain Avenue Murray Hill, N. J. 07974	25	143
3	72/2	Air Products and Chemicals, Inc. Specialty Gas Department P. O. Box 538 Allentown, Pa. 18105	136	540
		Alfa Products--see Ventron Corp. Alfa Prod.		
4	72/4	Alpha Analytical Laboratories Division of Alpha Metals Inc. 56 Water Street Jersey City, N. J. 07304	180	117
5	72/5	Aluminum Company of America ALCOA Laboratories Alcoa Center, Pa. 15069	403	
6	72/7	American Petroleum Institute Standard Reference Materials Carnegie-Mellon University Schenley Park Pittsburgh, Pa. 15213	407	

B. INDEX OF SUPPLIERS

(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
7	72/8	American Smelting and Refining Company By-Product Sales 120 Broadway New York, N. Y. 10005	14	
8	72/9	Amersham/Searle Corporation 2636 S. Clearbrook Drive Arlington Heights, IL 60005	145	622
9	72/126	Analytical Supplies Development Corp. 48 Notch Road Little Falls, N. J. 07424	45	
10	72/10	Angstrom, Inc. 678 E. Huron River Drive P. O. Box 248 Belleville, Michigan 48111	16	40
11	72/11	Apache Chemicals, Inc. P. O. Box 17 Rockford, IL 61105	70	307
12	72/12	Apex Smelting Company Division of Amax Aluminum Co., Inc. 2537 W. Taylor Street Chicago, IL 60612	62	
13	72/13	Applied Science Laboratories, Inc. P. O. Box 440 State College, Pa. 16801		265

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>RM's</u>
14	72/14	Arro Laboratories, Inc. P. O. Box 686 Caton Farm Road Joliet, Ill. 60434	45	72
15	72/15	Atomergic Chemetals Company Division of Gallard-Schlesinger Mfg. Corp. 584 Mineola Avenue, Carle Place Long Island, N. Y. 11514	6	220
16	72/78	Baird-Atomic, Inc. 125 Middlesex Turnpike Bedford, Mass. 01730	176	
		Baker--See J. T. Baker Company		
17	72/112	Bio-Rad Laboratories 32nd and Griffin Avenue Richmond, Calif. 94804	46	
18	72/111	Bradford Scientific, Inc. P. O. Box 275 Marblehead, Mass. 01945	15	226
19	72/16	Brammer Standard Company 213 Essex Knoll Drive Coraopolis, Pa. 15108	548	613
20	72/110	Brinkmann Instruments, Inc. Cantiague Road Westbury, N. Y. 11590		5

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
21	72/84	Burdick and Jackson Laboratories 1953 South Harvey Street Muskegon, Michigan 49442	42	
		Bureau of Mines--See U.S. Dept. of the Interior		
22	72/82	Calbiochem 109 North Torrey Pines Road LaJolla, Calif. 92037	39	
23	72/131&142	California Bionuclear Corporation 7654 San Fernando Road Sun Valley, Calif. 91352	463	
24	72/17	Cannon Instrument Company P. O. Box 16 State College, Pa. 16801	29	
		Cargille--See R. P. Cargille		
25	72/87	Columbia Scientific Industries 11950 Jollyville Road P. O. Box 9908 Austin, Tx. 78766	752	30
26	72/118	Cominco American, Inc. Building 101 Spokane Industrial Park Spokane, Washington 99216		19

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>RM's</u>
27	72/18	Continental Oil Company Conostan Division P. O. Box 1267 Ponca City, Oklahoma 74601	52	1
28	72/90	Duke Scientific Corporation 445 Sherman Avenue Palo Alto, Calif. 94306	33	65
29	72/19	Eastman Kodak Company Eastman Organic Chemicals Rochester, N. Y. 14650	6	235
30	72/21	Electronic Space Products, Inc. 854 S. Robertson Blvd. Los Angeles, Calif. 90035	240	1128
31	72/109	EM Laboratories, Inc. 500 Executive Boulevard Elmsford, N. Y. 10523	10	
32	72/23	ESCO Corporation 2141 N.W. 25th Ave. Portland, Oregon 97210	1	62
33	72/24	Fisher—See Jarrel-Ash Division		
		E&J Scientific 79 Far Horizon Drive Monroe, Conn. 06468		230

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>RM's</u>
34	72/25	Foote Mineral Company Route 100 Exton, Pa. 19341	1	8
		Frederick Smith--See G. Frederick Smith		
35	72/26	Gallard Schlesinger Chemical Manufacturing Corporation 584 Mineola Avenue Carle Place, N. Y. 11514		91
36	72/81	General Graphites, Inc. First and Monroe Streets Bay City, Michigan 48706	53	7
37	72/28	G. Frederick Smith Chemical Company P. O. Box 23344 Columbus, Ohio 43223	68	17
38	72/29	Glidden-Durkee Division of SCM Corporation Metals Group P. O. Box 217 Johnstown, Pa. 15907	1	
39	72/30	Handy & Harman Fairfield Plant 1770 Kings Hwy. Fairfield, Conn. 06430	2	

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
Harshaw--See the Harshaw Chemical Company				
40	72/32	Huntington Alloys, Inc. Huntington, West Virginia 25720	32	
41	72/114	ICN Life Sciences Group 26201 Miles Road Cleveland, Ohio 44128	114	461
42	72/92	Janos Optical Corporation Route 35 Townshend, Vermont 05353	276	
35	72/35	Jarrel-Ash Division, Fisher Scientific Company Spectrographic Supplies Section 590 Lincoln Street Route 128 Waltham, Mass. 02154	225	23
44	72/37	J. T. Baker Chemical Company 222 Red School Lane Phillipsburg, N. J. 08865	130	818
45	72/105	Kawecki Berylco Industries, Inc. 220 East 42nd Street New York, N. Y. 10017		8

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
46	72/117	Lachat Chemicals, Inc. 1350 W. Meguon Road Meguon, Wisconsin 53092	44	
47	72/80	LaPine Scientific Company 6001 South Knox Avenue Chicago, Ill. 60629	57	
48	72/95	Leco Corporation 3000 Lakeview Avenue St. Joseph, Michigan 49085	137	30
		Linde--See Union Carbide Corporation, Linde Division		
		London Company--See The London Company		
49	72/43	Materials Research Corporation Orangeburg, N. Y. 10962	56	160
50	72/100	Metals Research Instrument Corporation 40 Robert Pitt Drive Monsey, N. Y. 10952	83	71
51	72/128	Miles Laboratories, Inc. Research Division Elkhart, Indiana 46514	20	31

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
		Mineral--See U.S. Mineral and Chemical Co.		
52	72/45	Monsanto Company 800 N. Lindbergh Blvd. St. Louis, Missouri 63166	3	
53	72/47	Nanogens--Analytical Specialists P. O. Box 1025 Watsonville, Calif. 95076	171	
		National Bureau of Standards--See U.S. Department of Commerce		
54	72/49	National Spectrographic Laboratories, Inc. 19500 South Miles Road Cleveland, Ohio 44128	109	
		New Brunswick Laboratory--See United States Department of Energy		
55	72/51	New England Nuclear Corporation 549 Albany Street Boston, Mass. 02118	121	168
56	72/98-46	NL Industries, Inc. Spectrographic Laboratory 2700 South Indiana Street Los Angeles, Calif. 90023	59	

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
57	72/123	Norell Chemical Company, Inc. Arbor Ave. and Clara St. Landisville, N. J. 08326	18	
58	72/129	Nuclepore Corporation 7035 Commerce Circle Pleasanton, Calif. 94566	39	
		Nucor Corporation--See Research Chemicals, Div. of Nucor Corp.		
59	72/91	Ortec, Inc. 100 Midland Road Oak Ridge, Tenn. 37830	2	
60	72/96	Pfaltz & Bauer, Inc. 375 Fairfield Avenue Stamford, Conn. 06902	31	121
61	72/52	Phillips Petroleum Company Special Products Division Bartlesville, Oklahoma 74004	124	24
62	72/86	Polyscience Corporation 6366 Gross Point Road Niles, Illinois 60648	16	34

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
63	72/119	Research Chemicals Division of Nucor Corp. P. O. Box 14588 Phoenix, Arizona 85063	32	
64	72/99	Research Organic/Inorganic Chemical Corp. 11686 Sheldon Street Sun Valley, Calif. 91352	148	140
65	72/54	R. P. Cargille Laboratories, Inc. Cargille Scientific Inc. Cedar Grove, N. J. 07009	251	
66	72/134	Rutherford Research Products Company Box 249 Rutherford, N. J. 07070	8	
67	72/55	Sawyer Research Products, Inc. 35400 Lakeland Boulevard Eastlake, Ohio 44094	24	
68	72/56	Scientific Gas Products, Inc. 513 Raritan Center Edison, N. J. 08817	24+	numerous

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
69	72/57	Sensorex 17502 Armstrong Ave. Irvine, Calif. 92705	46	
70	72/135	Service Physical Testers Division of Service Diamond Tool Co. 6169 Lakeshore Road Port Huron, Michigan 18060	1+	numerous
71	72/121	Sigmund Cohn Corporation 121 So. Columbus Ave. Mount Vernon, N. Y. 10553	2	
72	72/58	Smith and Underwood Laboratories 1023 Troy Court Troy, Michigan 48084	55	
73	72/59	Spex Industries, Inc. 3880 Park Avenue Metuchen, N. J. 08840	145	299
74	72/60	Supelco, Inc. Supelco Park Bellefonte, Pa. 16823	73	

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
75	72/62	Texas Instruments, Inc. Research Building 13500 North Central Expressway Dallas, Texas 75222	1	
76	72/31	The Harshaw Chemical Company Crystal and Electronic Products Development 6801 Cochran Road Solon, Ohio 44139	51	11
77	72/65	The London Company 811 Sharon Drive Cleveland, Ohio 44145	2	14
78	72/85	Tousimis Research Corporation P. O. Box 2189 Rockville, Md. 20852	12	20
79	72/108	Twin City Testing Corporation 107-111 Goundry Street N. Tonawanda, N. Y. 14120		
80	72/66	Ultra Carbon Corporation First and North Madison Streets Bay City, Michigan 48706	12	154

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
81	72/94	Union Carbide Corporation Carbon Products Division 270 Park Avenue New York, N. Y. 10017	76	13
82	72/67	Union Carbide Corporation Chemicals & Plastics P. O. Box 8361 South Charleston, W. Va. 25303	2	2
83	72/115	Union Carbide Corporation Linde Division P. O. Box 372 51 Cragwood Road South Plainfield, N. J. 07080	12	
84	72/68	Union Carbide Corporation Nuclear Division P. O. Box P Oak Ridge, Tenn. 37830	135	
85	72/70	U. S. Department of Energy New Brunswick Laboratory P. O. Box 150 New Brunswick, N. J. 08903	20	
86	72/76	U. S. Department of Commerce National Bureau of Standards Office of Standard Reference Materials Washington, D. C. 20234	904	17

B. INDEX OF SUPPLIERS
(Continued)

<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
87	72/132	U. S. Department of the Interior Bureau of Mines, Branch of Engineering Box H 4372 Herring Plaza Amarillo, Texas 79101	2	3
88	72/69	U. S. Mineral and Chemical Corporation 129 Hudson Street New York, N. Y. 10013	251	
89	72/79	U. S. Steel Corporation 600 Grant Street Pittsburgh, Pa. 15230	35	
90	72/127	Var-Lac-Oid Chemical Company 666 South Front Street Elizabeth, N. J. 07202	59	
91	72/74	Ventron Corporation Alfa Products 152 Andover Street Danver, Mass. 01923	232	236

B. INDEX OF SUPPLIERS
(Continued)

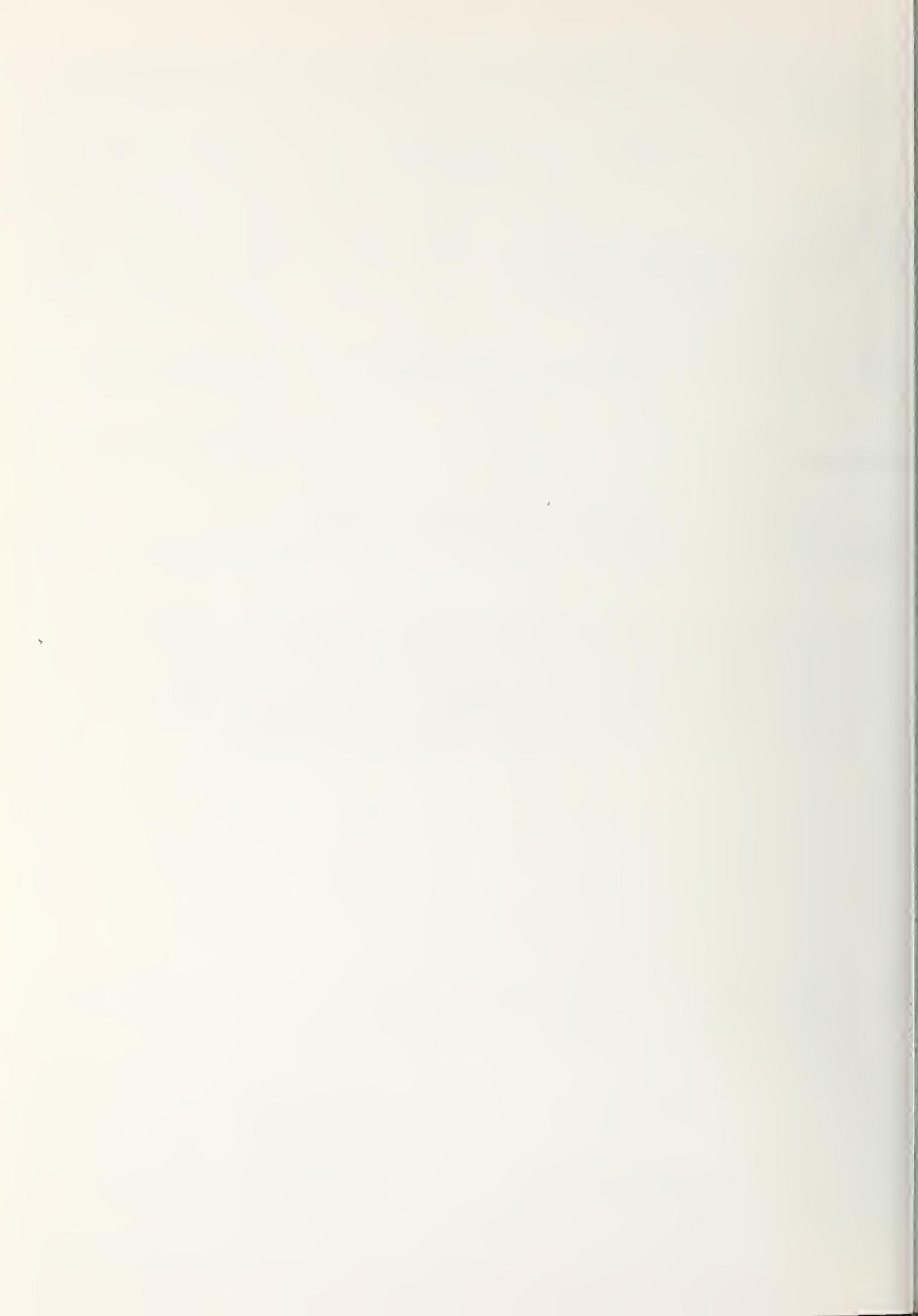
<u>Supplier Number</u>	<u>NBS File #</u>	<u>Supplier</u>	<u>Number of CRM's</u>	<u>Number of RM's</u>
92	72/124	Westinghouse Electric Corporation Electronic Tube Division P. O. Box 284 Elmira, N. Y. 14902	140	360
93	72/83	Wilks Scientific Corporation P. O. Box 449 So. Norwalk, Conn. 06856	109	—

REFERENCES

- (1) Astin, A. V., Report on the Symposium on an International Standard Reference Materials Program, *Metrologia*, 6, 33 (1970).
- (2) Seward, R. W. (ed.), Standard Reference Materials and Meaningful Measurements, *NBS Spec. Publ. 408* (1975).
- (3) Cali, J. P. and Stanley, C. L., Measurement Compatibility and Standard Reference Materials, *Ann. Rev. Mat'l. Sci.*, 5, 329 (1975).
- (4) Cali, J. P., The NBS Standard Reference Materials Program: An Update, *Anal. Chem.*, 48, 802A (1976).
- (5) Cali, J. P., et al., The Role of Standard Reference Materials in Measurement Systems, *NBS Monograph 148* (1975).
- (6) Cali, J. P., International Criteria for Reference Materials, from Quality Control in Clinical Chemistry, Walter de Gruyter, New York (1975).

N O T E S

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET		1. PUBLICATION OR REPORT NO. NBS SP 260-57	2. Gov't Accession No.	3. Recipient's Accession No.
4. TITLE AND SUBTITLE Standard Reference Materials: GUIDE TO UNITED STATES REFERENCE MATERIALS		5. Publication Date February 1978		
		6. Performing Organization Code		
7. AUTHOR(S) J. Paul Cali and Tomasz Plebanski		8. Performing Organ. Report No.		
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234		10. Project/Task/Work Unit No.		
		11. Contract/Grant No.		
12. Sponsoring Organization Name and Complete Address (Street, City, State, ZIP) Same as item 9.		13. Type of Report & Period Covered		
		14. Sponsoring Agency Code		
5. SUPPLEMENTARY NOTES Library of Congress Catalog Card Number: 77-28819				
6. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.) Summarized is a list of reference materials produced and distributed by U.S. manufacturers, both public and private. Extensive tables are indexed by use to which reference materials may be put. Properties covered include: chemical composition (analytical chemical purposes), chemical composition (high purity), physical properties, engineering and technological properties, and biochemical properties. Names and addresses of 93 U.S. producers and/or distributors are included.				
7. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons) Measurement; reference materials; standardization; Standard Reference Materials.				
8. AVAILABILITY <input checked="" type="checkbox"/> Unlimited <input type="checkbox"/> For Official Distribution. Do Not Release to NTIS <input checked="" type="checkbox"/> Order From Sup. of Doc., U.S. Government Printing Office Washington, D.C. 20402, SD Stock No. SN003-003 <input type="checkbox"/> Order From National Technical Information Service (NTIS) Springfield, Virginia 22151		19. SECURITY CLASS (THIS REPORT) UNCL ASSIFIED	21. NO. OF PAGES. 55	
		20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price \$2.20	



NBS TECHNICAL PUBLICATIONS

PERIODICALS

JOURNAL OF RESEARCH—The Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology, and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent NBS publications in NBS and non-NBS media. Issued six times a year. Annual subscription: domestic \$17.00; foreign \$21.25. Single copy, \$3.00 domestic; \$3.75 foreign.

Note: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

DIMENSIONS/NBS

This monthly magazine is published to inform scientists, engineers, businessmen, industry, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on the work at NBS. The magazine highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, it reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing.

Annual subscription: Domestic, \$12.50; Foreign \$15.65.

NONPERIODICALS

Monographs—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NBS, NBS annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

Applied Mathematics Series—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a world-wide program coordinated by NBS. Program under authority of National Standard Data Act (Public Law 90-396).

NOTE: At present the principal publication outlet for these data is the Journal of Physical and Chemical Reference Data (JPCRD) published quarterly for NBS by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements available from ACS, 1155 Sixteenth St. N.W., Wash., D.C. 20056.

Building Science Series—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The purpose of the standards is to establish nationally recognized requirements for products, and to provide all concerned interests with a basis for common understanding of the characteristics of the products. NBS administers this program as a supplement to the activities of the private sector standardizing organizations.

Consumer Information Series—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

Order above NBS publications from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Order following NBS publications—NBSIR's and FIPS from the National Technical Information Services, Springfield, Va. 22161.

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. Register serves as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NBS Interagency Reports (NBSIR)—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Services (Springfield, Va. 22161) in paper copy or microfiche form.

BIBLIOGRAPHIC SUBSCRIPTION SERVICES

The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:

Cryogenic Data Center Current Awareness Service. A literature survey issued biweekly. Annual subscription: Domestic, \$25.00; Foreign, \$30.00.

Liquified Natural Gas. A literature survey issued quarterly. Annual subscription: \$20.00.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: \$30.00. Send subscription orders and remittances for the preceding bibliographic services to National Bureau of Standards, Cryogenic Data Center (275.02) Boulder, Colorado 80302.

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

OFFICIAL BUSINESS

Penalty for Private Use, \$300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215



SPECIAL FOURTH-CLASS RATE
BOOK
